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Short Communication

Impact of Blockchain in Supply Chain in Two Industries

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Abstract

The supply chain can span over hundreds of stages, multiple geographical (international) locations, a multitude of invoices and payments, have several individuals and entities involved, and extend over months of time. Manufacturers and consumers can benefit by tracking the movement of parts throughout the supply chain. Due to the complexity and lack of transparency of current supply chains, there is interest in how blockchains might transform the supply chain and logistics industry. Blockchain technology can bring transparency and efficiency to supply chain recordkeeping by providing a permanent, secure record of transactions that are then grouped into "blocks". Transactions are recorded only after consensus among participants, and the blocks cannot be removed or altered after the event. Although the blockchains and supply chains are used by several industries, in order to manage the scope of the research this paper focuses their use on the two industries – food and pharmaceuticals.

Keywords: supply chain, blockchain, security, trust

1 Introduction

Companies in the food industry are beginning to implement blockchain to track identification, transportation, and sales of food so that every touchpoint from farm origination, batch numbers, factory and processing data, expiration dates, storage temperatures, and shipping detail are permanently recorded. In case of a food contamination, businesses can identify the origin of the problem by referencing processing and handling details in the chain. For example, at the heart of the Denver-based company Chipotle's crisis was the ever-present problem faced by companies that depend on multiple suppliers to deliver parts and ingredients: a lack of transparency and accountability across complex supply chains. Unable to monitor its suppliers in real time, Chipotle could neither prevent the contamination nor contain it in a targeted way after it was discovered. We believe that the similar problem is faced by companies that are running their business using traditional supply chains. At present a number of startups and corporations are exploring a radical solution to this problem using a blockchain to transfer title and record permissions and activity logs so as to track the flow of goods and services between businesses and across borders.

Blockchains and supply chains are also being used by pharmaceuticals companies with medicines and drugs being transported between businesses and across borders. With a digital foundation in place companies can capture, analyze, integrate, easily access, and interpret high quality, real-time data, using technologies such as predictive analytics, artificial intelligence, blockchain, and robotics to make the supply chain better. Blockchains are beginning to revolutionize how parties collaborate in flexible supply networks. Robots are improving productivity and margins in retail warehouses and fulfillment centers. Delivery drones and self-driving vehicles are being tested by businesses to reduce the order to delivery cycle. This paper discusses how incorporating blockchains within the supply chain can benefit the food and pharmaceutical industries and subsequent impact on their performance. Specifically, the purpose of this paper is (1) to explore and understand the fundamental concepts of supply chain management (SCM) and blockchain, and (2) how these two concepts can be integrated in an innovative way to alleviate the complexity and "trust" issues present in the present form of complex supply chain.

The paper is divided into several sections. The first two sections discuss the basic concepts of supply chain and blockchain respectively, and the third section focuses on the rationale for integrating supply chain and blockchain. The fourth section provides the examples of projects in food industry and healthcare and the concluding section summarizes the application of blockchain in supply chain in other industries and remarks about the current work in progress.

2 What is Supply Chain and Supply Chain Management (SCM)?

The business dictionary defines the supply chain as the overall network of various entities such as vendors, manufacturers, retailers that are directly or indirectly interlinked to provide services to the customers. The network is chain of entities that transform the inputs into a value-added output to the next entity in the chain. For example, a manufacturer in the network converts the raw material it receives from a vendor into products that will be stored in the warehouses which subsequently supplies the products to the distribution centers that will deliver the products to the retailers. The retailers then provide the final products to the customers. In short the concept of "chain" is called the "value-chain" since each stage of the link adds value to its input. Without such a chain it would be difficult to provide the final product to the customer. Producers compete with each other only through their supply chains, and no degree of improvement at the producer's end can make up for the deficiencies in a supply chain which reduce the producer's ability to compete.

2.1 Challenges in Managing Supply Chain

There are several challenges in managing supply chains as identified by Leong et al. (2018). The key challenges are:

(1) Coordinating process and digital transformation across multiple, disbursed, and often disconnected supply chain actors such as producers, brokers, transporters, processors, wholesalers, retailers, and consumers who may not trust each other.
(2) Onerous and costly data reconciliation processes due to large amount of data duplications and regularity requirements.
(3) Lack of product traceability due to product information ambiguity, resulting from logging vague and uncertain product characteristics which are hard to trace. Within the supply chain there are several bottlenecks that make end-to-end traceability more challenging.
(4) Lack of connectivity, particularly with upstream suppliers due to incompatible and different types of hardware and software components.
(5) In general, there is a security and trust issues in overall management of supply chain management (SCM).

The security and trust issues are critical in the overall success of the supply chain, and integrating the supply chain and blockchain will help alleviate the security and trust issues. In the next section the overall concept of blockchain is discussed.

3 What are Blockchain and Distributed Ledger Technologies?

According to Investopedia.com blockchain is defined as a ledger of any transactions or contracts maintained in decentralized form across different locations and people, eliminating the need of a central authority to keep a check against manipulation. It is a digitized, decentralized, public ledger of all cryptocurrency transactions. All the information on it is securely and accurately stored using cryptography and can be accessed using keys and cryptographic signatures. It is a new type of data system that maintains and records data in a way that allows multiple stakeholders to confidently share access to the same data and information. The three goals of the blockchain are – to ensure the anonymity of blockchain users, provide a public record or ledger of a set of transactions that cannot be altered once verified and agreed to, and to be independent of any central or trustworthy authority (Waldo 2019). On the blockchain, trust is established between the parties without intermediaries like banks or technology companies by using encrypted codes. Once entered, transactions on the shared "register" cannot be falsified or destroyed, making the records permanent, immutable, and transparent. Blockchain uses distributed ledger technology (DLT). A distributed ledger is a database that is consensually shared and synchronized across network spread across multiple sites. It allows transaction records to have public witnesses which essentially makes cyberattack more difficult.(Investopedia.com, Sept. 30, 2018)

3.1 Distributed Ledger Technology (DLT)

A blockchain is based on distributed ledger technology (DLT) that is shared by multiple entities operating on a distributed network. (Christine Leong et al. 2018). The blockchain technology enables recording and storing of every transaction across the network. Every blockchain is a DLT, however; every DLT is not blockchain (Ray 2018). Each of these concepts requires decentralization and consensus among nodes. However, the blockchain organizes data in blocks, and updates the entries using an append-only structure. In essence, a blockchain is a continuously growing list of records. Its append-only structure only allows data to be added to the database (See Figure 1). Previously entered data on earlier blocks cannot be altered or deleted. As a result, Blockchain technology is well-suited for recording events, managing records, processing transactions, tracing assets, and voting (Ray 2018). While centralized lodgers are susceptible to cyber-attack, distributed lodgers are harder to breach because all the distributed copies need to be attacked simultaneously for an attack to be successful. (Investopedia.com, Sept. 20, 2018)

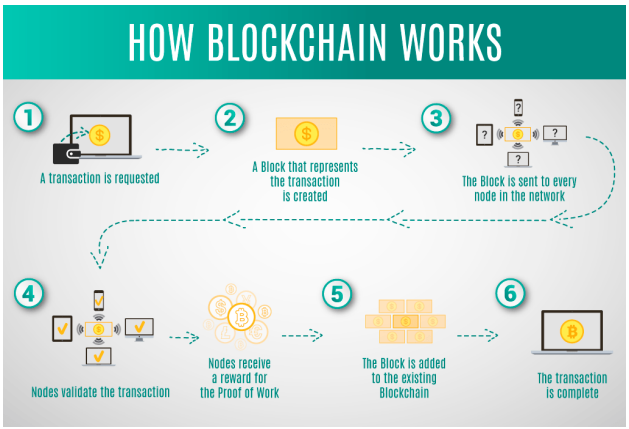

Figure 1: https://mlsdev.com/blog/156-how-to-build-your-own-blockchain-architecture

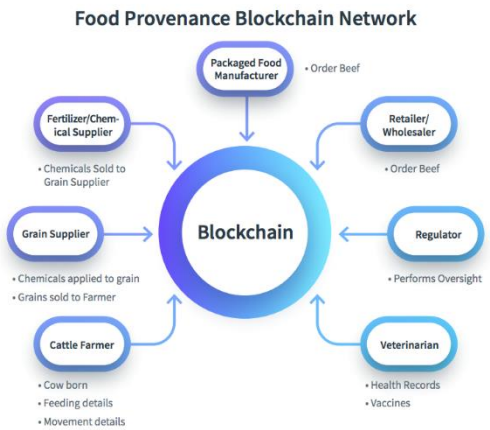

Figure 2: https://dzone.com/articles/take-big-data-to-the-next-level-with-blockchain-ne

4 Why Integrate Supply Chain and Blockchain?

A lack of transparency and accountability across complex supply chains were the key factors that led to Denver-based company Chipotle's crisis (Casey and Pindar 2017). E. Coli outbreak at Chipotle in 2015 led to a major dive in their sales and subsequent 42% drop in their stock prices. The management was not able to monitor suppliers in real time. When tainted medicines make people sick, often it results in death or debilitating illness to the patient. The legal and reputational risks can be severe enough for the pharmaceutical manufacturer to go out of business. Regulators search to find the source of the tainted drug and the process is long, expensive, and inconclusive. Similar problem is faced by companies that are running their business using traditional supply chain due to the complexity and inability to monitor the activities in real time. At present a number of startups and corporations are exploring the use of blockchain to transfer and record permissions and activity logs to track the flow of goods and services between businesses and across borders.

4.1 Key reasons for using blockchain solutions to alleviate supply chain complexity

Leong et al. (2018) provides a detailed coverage of rationale for integrating supply chain and blockchain in the "blockchain feasibility study" conducted by Accenture commissioned and funded by The Moore Foundation. Following section provides the details of the factors they identified in their feasibility study.

(1) Transparency and auditability help streamline the process of sharing information resulting in improved accountability and trust. In addition, it also shows near real-time updates about the product.

(2) Blockchain facilitates data sharing without the need to change the systems that each entity has and thus allowing greater traceability of product across multiple partners, locations, and facilities.

(3) Blockchain supports streamlined operations and purchase process automation. It can automatically enforce participant-agreed rules and process steps that can facilitate, verify, and execute in terms of an agreement between counterparties without the need for a human intermediary.

(4) Through its inherent structure, blockchain can enable security and trust in the source of data coming from multiple data streams, thus ensuring that the data has not been altered.

(5) Blockchain can simplify and expedite contract management process. This helps moving the product more efficiently, especially when it involves the movement of the perishable product such as food and medicine. It also facilitates measuring the performance data since they are can be readily collected.

(6) Perishable items moving through the supply chain faces challenges from finance and insurance companies, especially the small businesses. Blockchain offers high level of certainty in where the data comes from, thus improving confidence of the lender who can offer an insurance to the small businesses a reasonable premium.

(7) Blockchain also creates opportunities and visibility for small businesses an access into demand upstream for access to better prices and production control. It also helps suppliers to tweak their delivery plan and improve their efficiency.

(8) Blockchains have also resulted into reinvention of the new business models and sustainable product differentiation.

Supply chains are by nature complex, inefficient, and have many intermediaries. Some of the challenges in supply chain are payments, legal contracts, customs, provenance and dispute resolution. Blockchains have started to prove their value in the supply chains in many industries by reducing costs and improving efficiency and transparency. The art world uses it to check the provenance of the item and to protect the parties from rampant and fraud. With consumers demanding to know the source of materials, labor, processes, environmental impact and ethical issues, the manufacturing process needs a transparent and immutable record from the source to final point of sale. Integrating blockchain with supply chain can provide the transparency and immutability of record. The technology is particularly useful to the food and pharmaceutical supply chains from around the world, where fraud and corruption erode the trust of stakeholders in the organization's ability to protect their interests. Following sections provides examples of integrating blockchain solutions into supply chains in food, healthcare and other industries.

4.2 Integrating blockchain solution into food industry supply chain

When raw or prepared food items make people sick, grocery stores and restaurants pull them off their shelves, and regulators search to find the source of tainted food. Often the process is long and expensive with a lot of food wasted. Many companies are working on improving the traceability in the food supply chain using edible bar codes and blockchain technology to trace the movement of the item through the supply chain (See Figure 2). Safe Traces sells the technology of barcoding food to farmers, packers, and food processor. The barcodes are invisible, tasteless, and safe to eat. Food supply chains are more global and complex than before, making it impossible for grocers and restaurants to trace the origin of the food they sell. Blockchain improves the transparency of data by providing permanent, secure record of permanent transactions of all touchpoints from originating farms, batch numbers, factory processing data, expiration dates, storage temperatures, and shipping details. It provides end-to-end view of the supply chain, and makes it possible to pinpoint the source of contamination and strategically remove contaminated packages only. Blockchains can help in identifying fraud in food industry where some food items are faked, diluted, or adulterated. The secure and traceable records in the system can eliminate such fraudulent practices. At Walmart, blockchain is used to manage supply chain data for more than 30 products after the retailer tested the technology in its mango supply chain between US, Mexico, and South America. The products include berries, mangoes, and other fruits. After the mango is picked, it makes many stops before arriving at the store shelf. All parties handling the fruit including farmers, packing workers, and several others send data about

harvest dates, locations, and images to Walmart's blockchain. This continuous monitoring is simpler and safer than the old method of barcodes, scanners, paper forms, and various databases in the old supply chain. As an example, Walmart managers tested a simulated recall tracing the origin of a bag of sliced mangoes and found that the process took 2.2 seconds in the blockchain system vs. 6 days and 18 hours in the old system. The speed in tracing the bad batch of mangoes will prevent illness and related issues to consumers, as well as preventing loss of revenue by the ability to pull just the tainted batch off the shelf and leave the rest of the mangoes on the shelves.

4.3 Integrating Blockchain solution into healthcare supply chain

Blockchain technology can be used to provide secure and accurate medical history for every individual patient in the healthcare supply chain. Today a tangle of incompatible records, cause poor quality of patient care and bottlenecks in the processing of medications, sometimes leading to wrongful denials of insurance coverages and costly errors. By providing patients, insurers, and providers simultaneous access to a single body of encrypted data, blockchain helps to ensure the integrity and authenticity of the information. MedRec, the blockchain system developed by Massachusetts Institute of Technology is designed for patients to be able to manage their own records and give permissions to doctors and providers to access and update the records. Change Healthcare, a Nashville-based health network uses blockchain system for processing insurance claims by providing a "single source" for the physicians, dentists, and pharmacies in the system. The company is developing other application that can be run on the platform such as automated processing of claims, and digital verification of patient and provider identities. An alliance of healthcare insurers including Humana, Multiplan, Quest diagnostics, and United Health are trying to create a blockchain based platform to share information. State of Illinois is looking for ways to use blockchain to check the licensing status of a medical provider.

4.3 Integrating blockchain solution into other industry supply chains

In addition to the food and health care industries, applications of the blockchain in supply chains can also be used in other industries. Academic institutions can create blockchain for student records from all the educations institutions with the students' permission. Human resource departments of prospective employers can tap into the same data and be assured that the data is authentic. Performing artists can have control over intellectual property while it is going through the entertainment industry supply chain, without having to worry about losing owed income from producers/suppliers. Supply chains exist in every aspect of our daily life, and can be streamlined using blockchain.

Many technology firms, financial services, and audit firms are working on blockchain based projects in collaboration with their clients. However, while eliminating the inefficient processes and excessive costs blockchain comes with some risks that need to be managed. Chief among the risks are legal, operational, key management, code and cryptography, consensus and governance risks. All of these risks must be reviewed diligently by the firms and managed on an ongoing basis, along with continuous education to stay ahead of this emerging technology.

5 Conclusion

Blockchain is not a panacea to eliminate all the problems with the complex supply chain. However, it is one of the viable and reasonably trusted solutions in the absence of any other confirmed approach to alleviate the undesired aspect of supply chain complexity. Although in reality there is nothing in this universe that can assure hundred percent "trust" in any process, we have to rely on something to certain extent. The cost of "trust" depends upon what value it brings to the decision maker (Waldo 2019). The cost is associated with the time spent in evaluating and assessing all the components and people involved in the blockchain.

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